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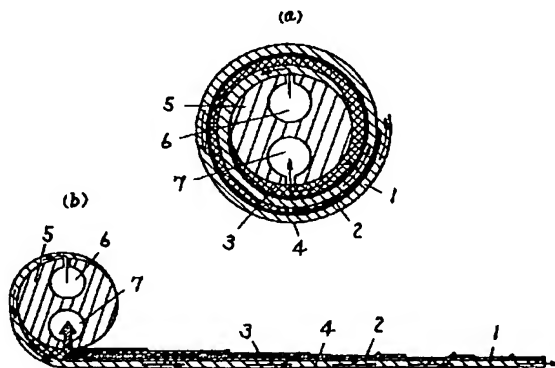
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(54)【発明の名称】 気体分離膜モジュール

(57)【要約】

【目的】 透過気体流路中での圧力損失による性能低下がなく、しかも体積効率の高い気体分離膜モジュールを提供する。

【構成】 透過気体流路材3を一部が気体非透過膜4で構成された平膜状の気体分離膜2で挟み、原料気体流路材1と共に、給気管6と排気管7とが一体となった給排気管5の周りにスパイラル状に巻回し、巻始めの一端は原料気体流路材1と給気管6が連通し、かつ、透過気体流路材3と排気管7が連通するように給排気管5に気体分離膜2を接着し、巻終わりの一端は透過気体流路材3を気密に閉じるように気体分離膜2を袋状とし、巻回方向の両側端部は原料気体流路と透過気体流路を気密に隔てるように封止し、巻終わりから巻始めに至る過程で、透過気体流路材3を順次厚くした構成を有している。



【特許請求の範囲】

【請求項1】 透過気体流路材を平膜状の気体分離膜、あるいは一部が気体非透過膜で構成された平膜状の気体分離膜で挟み、前記透過気体流路材を挟んだ気体分離膜と原料気体流路材とを重ねて一組とし、この少なくとも一組を、原料空気を供給する給気管と透過気体を排気する排気管とが一体となった給排気管の周りにスパイラル状に巻回し、巻始めの一端は原料気体流路材と給排気管の給気管が連通し、かつ、透過気体流路材と給排気管の排気管が連通するように給排気管に前記気体分離膜を接

着し、巻終わりの一端は透過気体流路を気密に閉じるように前記気体分離膜を袋状とし、巻回方向の両側端部は原料気体流路と透過気体流路を気密に隔てるように封止した気体分離膜モジュールであって、巻終わってから巻始めに至る過程で、前記透過気体流路材を順次厚くした気体分離膜モジュール。

【請求項2】 透過気体流路材を平膜状の気体分離膜、あるいは一部が気体非透過膜で構成された平膜状の気体分離膜で挟み、前記気体分離膜の両側端部を封止し、前記透過気体流路材を挟んだ気体分離膜と原料気体流路材とを重ねて一組とし、この少なくとも一組を、排気管の周りにスパイラル状に巻回し、巻始めの一端は透過気体を排気する排気管と透過気体流路材が連通するように排気管に前記気体分離膜を接着し、巻終わりの一端は透過気体流路を気密に閉じるように前記気体分離膜を袋状とした気体分離膜モジュールであって、巻終わってから巻始めに至る過程で、前記透過気体流路材を順次厚くした気体分離膜モジュール。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は平膜の気体分離複合膜を巻回してなるスパイラル型気体分離膜モジュールに関するものである。

【0002】

【従来の技術】一般に平膜を巻回してなるスパイラル型の気体分離膜モジュールは、透過気体流路を形成する透過気体流路材を平膜状の気体分離膜で挟んで、穴を有する中空管の穴に透過気体流路が連通するように中空管に気体分離膜を接着し、原料気体流路を形成する原料気体流路材と共に中空管の周りに巻回して構成される。また、発明者等は特願平4-249711号において、独立した複数の穴を有する中空管の穴に、透過気体流路材及び原料気体流路材がそれぞれ連通するように中空管に気体分離膜を接着し、中空管の周りに巻回して構成される気体分離膜モジュールを提案した。

【0003】上記従来の気体分離膜モジュールの気体の分離、濃縮について原料気体を空気とし窒素を分離、濃縮する場合について図を用いて説明する。

【0004】図5、図6は従来のスパイラル型の気体分離膜モジュールの例で、図5(a)、(b)はそれぞれ

従来例1の気体分離膜モジュールの断面図、気体分離膜モジュールを展開した断面斜視図、図6(a)、

(b)、(c)はそれぞれ従来例2の気体分離膜モジュールの断面図、気体分離膜モジュールを展開した断面斜視図、気体の流れを示す気体分離膜モジュールを展開した断面図である。

【0005】図5において、22は気体分離膜を多孔質支持体上に形成した平膜状の気体分離複合膜であり、透過気体流路材23を挟むように折り返してあり、折り返し部分が巻き終わりになっている。また気体分離複合膜22の巻回方向（中空管に対して垂直方向）の両側端部は封止材25で封止してあり、巻始めの一端は透過気体流路材23と中空管26が連通するように気体分離複合膜22が中空管26に接着されている。原料気体流路は解放されている。

【0006】上記構成において、原料気体流路材21で構成された原料気体流路に原料空気を矢印（実線）の方向に供給すると、原料空気は酸素を優先的に透過する気体分離複合膜22の表面上を流れていく。その時酸素は優先的に気体分離複合膜22を透過し透過気体流路材23で構成された透過気体流路を矢印（破線）の方向に流れて行き、中空管26より排出される。そのため気体分離複合膜上を通過し、気体分離膜モジュールから出て来た空気は窒素が濃縮されることとなる。

【0007】また、図6は、透過気体流路材23を平膜状の気体分離複合膜22と気体非透過膜24で挟み、原料気体流路材21と共に、独立した給気管28と排気管29を有する給排気管27の周りに巻回したスパイラル型の気体分離膜モジュールで、給気管28と原料気体流路材21及び排気管29と透過気体流路材23がそれぞれ連通するように気体分離複合膜22及び気体非透過膜24を給排気管27に接着させ、更に巻回方向の両側端部を原料気体流路と透過気体流路を気密に隔てるように封止してある。

【0008】このスパイラル型気体分離膜モジュールの給気管28から原料空気を供給すると、原料気体供給流路を矢印（実線）の方向に気体分離複合膜22の表面上を流れ、従来例1の気体分離膜モジュールと同様に酸素の優先的な透過により、窒素を濃縮できる。この気体分離膜モジュールでは原料空気が巻回方向に流れることによって、原料空気が気体分離複合膜表面上を流れる距離を長くすることができ、濃縮効率の高い気体分離膜モジュールが得られる。

【0009】

【発明が解決しようとする課題】しかしながら、いずれにしても上記従来の気体分離膜モジュールの透過気体流路材23の厚さは、巻終わってから巻始めに至る過程において一定であるため、気体の流れる流路の断面積が一定となる。これに対し、透過気体流路材23中を流れていく透過気体の流量は、図6(c)に示すように気体分離

複合膜の巻き終わりから巻き始めに至る過程で、順次積算され増大していき、排気管27と連通する部分では、気体分離膜22全面で透過した量の透過気体が通過することになる。即ち、一定の厚さ（流路の断面積が一定）の透過気体流路材中では、流量の増大に比例し流動抵抗も増大し、透過気体流路材の厚さが充分でない場合には、流動抵抗が大きくなり圧力損失を生じて、気体分離膜を介して所定の圧力差が得られなくなり、充分な性能を確保できなくなる。

【0010】また、透過気体流路中、透過気体流量が最も多くなる排気管と連通する部分において、圧力損失が十分に小さくなるように透過気体流路材の厚さを決定した場合、透過気体流路材の厚さが一定であるために排気管から巻終わり部分に至るにつれて必要以上に透過気体流路材が厚くなることになり、巻回した気体分離膜モジュールの外形が大きくなり、気体分離膜モジュールの性能に対する体積効率が低下することになる。

【0011】一般的にスパイラル型の気体分離膜モジュールにおいては、原料気体を加圧供給する方式がとられているため、供給気体の体積は大気圧下の数分の1になる。これに対して透過気体は大気圧となるため、透過気体の流量は供給気体の数倍になり、透過気体流路材の厚さは原料気体流路材の数倍必要となる。従って気体分離膜モジュールにおける透過気体流路材の占める体積比率は高くなり、透過気体流路材を如何に薄くできるかが、体積効率の向上、即ち性能向上及び小型化の重要な課題となる。

【0012】本発明は上記従来の課題を解決するもので、濃縮効率及び体積効率の優れた気体分離膜モジュールを提供することを目的とする。

【0013】

【課題を解決するための手段】この目的を達成するために本発明の気体分離膜モジュールは、透過気体流路材を平膜状の気体分離膜、あるいは一部が気体非透過膜で構成された平膜状の気体分離膜で挟み、上記透過気体流路材を挟んだ気体分離膜と原料気体流路材とを重ねて一組とし、この少なくとも一組を、原料空気を供給する給気管と透過気体を排気する排気管とが一体となった給排気管の周りにスパイラル状に巻回し、巻始めの一端は原料気体流路材と給排気管の給気管が連通し、かつ透過気体流路材と給排気管の排気管が連通するように給排気管に上記気体分離膜を接着し、巻終わりの一端は透過気体流路を気密に閉じるように上記気体分離膜を袋状とし、巻回方向の両側端部は原料気体流路と透過気体流路を気密に隔てるように封止した気体分離膜モジュールであって、巻終わりから巻始めに至る過程で、上記透過気体流路材を順次厚くした構成を有している。

【0014】また透過気体流路材を平膜状の気体分離膜、あるいは一部が気体非透過膜で構成された平膜状の気体分離膜で挟み、この気体分離膜の両側端部を封止

し、上記透過気体流路材を挟んだ気体分離膜と原料気体流路材とを重ねて一組とし、この少なくとも一組を排気管の周りにスパイラル状に巻回し、巻始めの一端は透過気体を排気する排気管と透過気体流路材が連通するように排気管に上記気体分離膜を接着し、巻終わりの一端は透過気体流路を気密に閉じるように上記気体分離膜を袋状とした気体分離膜モジュールであって、巻終わりから巻始めに至る過程で、上記透過気体流路材を順次厚くした構成を有している。

【0015】

【作用】この構成により、気体分離膜モジュールにおいて体積比率の高い透過気体流路材を削減でき、しかも巻終わりから巻き始めに至る過程において透過気体の流量が順次増大しても、それに伴い透過気体流路材が順次厚くなり流路が大きくなるため、圧力損失による性能低下の無い、体積効率の高い気体分離膜モジュールを実現できる。

【0016】

【実施例】

（実施例1）以下本発明の一実施例について、図面を参照しながら説明する。図1(a)は本実施例の気体分離膜モジュールの断面図、図1(b)、図2は気体分離膜モジュールを展開した断面図、図3は本実施例の使用例である。

【0017】図1において、1は原料気体流路材で、厚さ0.4mmの15メッシュのポリエチレン成形ネットを1枚用いてある。2は気体分離複合膜で、多孔質支持体上にポリ4メチルペンテン1の気体分離膜を積層し、更にその上にポリジメチルシロキサンを積層した非対称構造で、分離膜側が原料気体流路材1と相対するように配されている。

【0018】3は透過気体流路材で、厚さ0.4mmの15メッシュのポリエチレン成形ネットを巻終わりから100cm迄は1枚で、それ以降50cmごとに1枚ずつ増やして積層し構成されている。4は気体非透過膜で厚さ100μmのポリエステルフィルムである。5は給排気管で給気管6と排気管7が、長さ方向に独立して平行に配されており、給気管6、排気管7にはそれぞれ外部と連通する穴があいている。

【0019】上記の原料気体流路材1が給気管6に、透過気体流路材3が排気管7に連通するように、気体分離複合膜2及び気体非透過膜4を給排気管5に気密に接着し、原料気体流路材1から気体非透過膜4の材料を給排気管5の回りにスパイラル状に巻回した後、気体分離複合膜2の巻終わりの一端で気体分離複合膜2と気体非透過膜4を気密に接着し、他の二辺を図3のように封止材8によって原料気体流路と、透過気体流路を気密に隔てるように接着封止する。

【0020】以上のように構成された気体分離膜モジュールは、透過気体流路材のみ一定の厚さにして同様に作

成した気体分離膜モジュールに比較して、透過気体流路材の使用量はほぼ半分となり、気体分離膜モジュールの外径は30mm小さくなった。

【0021】また、図3に示すように、上記気体分離膜モジュールを圧力容器9内に収納し、給気管6から592Pa（5kgf/cm²G）に加圧された空気4、 2×10^{-4} m³/s（25l/min）を供給し、流量調節弁10から得られる窒素濃縮空気流量を 8.3×10^{-3} m³/s（5l/min）に調節したところ窒素濃度は97.5%であった。

【0022】以上のように本実施例によれば、透過気体流路材を気体非透過膜と平膜状の気体分離膜で挟み、透過気体流路材を挟んだ気体分離膜と原料気体流路材とを重ねて一組とし、この一組あるいは複数組を、原料空気を供給する給気管と透過気体を排気する排気管とが一体となった給排気管の周りにスパイラル状に巻回し、巻始めの一端は原料気体流路材と給排気管の給気管が連通し、かつ、透過気体流路材と給排気管の排気管が連通するように給排気管に気体非透過膜及び気体分離膜を接着し、巻終わりの一端は透過気体流路を気密に閉じるように非透過気体透過材と気体分離膜を袋状に接着し、巻回方向の両側端部は原料気体流路と透過気体流路を気密に隔てるように封止し、巻終わりから巻始めに至る過程で、透過気体流路材を順次厚くすることにより、体積効率の高い気体分離膜モジュールが得られる。

【0023】尚、本実施例の気体分離膜モジュールの透過気体流路材3を構成しているネットの積層数、及び積層しているそれぞれのネットの長さは、ネットの単位体積当たりの空間の割合、気体分離膜の気体透過性能、気体分離性能、気体分離膜モジュールの回収率（給気空気量に対する窒素濃縮空気量の比率）等によって最適な値が決定されるため、本実施例の値に限定されるものではない。

【0024】また本実施例の気体分離膜モジュールの透過気体流路材3は、ポリエチレンネットを積層して用いたが、これは例えばポリプロピレン、ポリ塩化ビニル等の樹脂を用いたネット、あるいはウレタン、ポリスチレン等を用いた発泡フォーム、あるいはポリエステル等を用いた不織布等、気体の流路を形成する成形樹脂品なら特に限定されるものではない。

【0025】更に本実施例では一定の厚みのネットを積層した構成としたが、図2の3-1に示すように、ネットや上記の流路材をなめらかに厚みが変わるように一体的に成形した構成としても良く、この場合には体積効率が良くなり、ネットの段差による気体分離膜の変形も回避でき、巻取り工数も削減できる。

【0026】（実施例2）以下本発明の第2の実施例について、図4を参照しながら説明する。

【0027】1は原料気体流路材で実施例1と同様な構成であるが、巻回方向の長さは2分の1になっている。

2は気体分離複合膜で実施例1と同様な構成であるが、透過気体流路材3を挟むように折り返し、折り返し部分が巻終わりとなるようにし、両側端部を封止してある。また気体分離複合膜2の折り返し部分には気体非透過膜4が接着されており、気体非透過膜4は気体分離複合膜2の外周を覆っている。3は透過気体流路材でこれも実施例1と同様な構成であるが、巻終わりから50cm迄が1枚で、それ以降25cmごとに1枚ずつ増やして積層した構成としている。

10 【0028】上記の原料気体流路材1が給気管6に、透過気体流路材3が排気管7に連通するように、気体分離複合膜2を給排気管5に気密に接着し、原料気体流路材1から気体非透過膜4の材料を給排気管5の回りにスパイラル状に巻回する。この気体分離膜モジュールの外径は実施例1の気体分離膜モジュールに比べ、10mm小さくなった。

【0029】以上のように構成された気体分離膜モジュールを図3に示すように圧力容器9内に収納し、給気管6から592Pa（5kgf/cm²G）に加圧された空気4、 2×10^{-4} m³/s（25l/min）を供給し、流量調節弁10から得られる窒素濃縮空気流量を 8.3×10^{-3} m³/s（5l/min）に調節したところ窒素濃度は97.4%であった。

【0030】以上のように本実施例によれば、一部が気体非透過膜で構成された平膜状の気体分離膜で透過気体流路材を挟み、この透過気体流路材を挟んだ気体分離膜と原料気体流路材とを重ねて一組とし、この一組あるいは複数組を、原料空気を供給する給気管と透過気体を排気する排気管とが一体となった給排気管の周りにスパイラル状に巻回し、巻始めの一端は原料気体流路材と給排気管の給気管が連通し、かつ、透過気体流路材と給排気管の排気管が連通するように給排気管に気体分離膜を接着し、気体分離膜の巻終わりの一端が気体分離膜の折り返し部分となるようにし、巻回方向の両側端部は原料気体流路と透過気体流路を気密に隔てるように封止し、巻終わりから巻始めに至る過程で、透過気体流路材を順次厚くすることにより、透過気体流路材を更に削減でき、体積効率をより向上できる。

【0031】

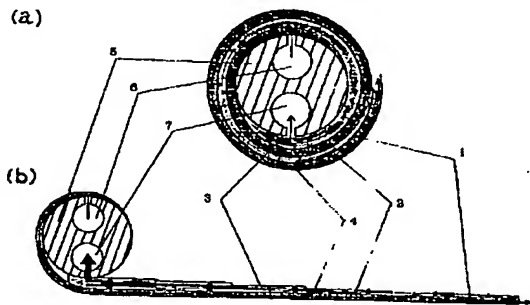
40 【発明の効果】以上のように本発明によれば、透過気体流路材を平膜状の気体分離膜、あるいは一部が気体非透過膜で構成された平膜状の気体分離膜で挟み、この透過気体流路材を挟んだ気体分離膜と原料気体流路材とを重ねて一組とし、この一組あるいは複数組を、原料空気を供給する給気管と透過気体を排気する排気管とが一体となった給排気管の周りにスパイラル状に巻回し、巻始めの一端は原料気体流路材と給排気管の給気管が連通し、かつ、透過気体流路材と給排気管の排気管が連通するように給排気管に気体分離膜を接着し、巻終わりの一端は透過気体流路を気密に閉じるように気体分離膜を袋状と

し、巻回方向の両側端部は原料気体流路と透過気体流路を気密に隔てるように封止し、巻終わりから巻始めに至る過程で、前記透過気体流路材を順次厚くした構成、または平膜状の気体分離膜、あるいは一部が気体非透過膜で構成された平膜状の気体分離膜で透過気体流路材を挟み、気体分離膜の両側端部を封止し、透過気体流路材を挟んだ気体分離膜と原料気体流路材とを重ねて一組とし、この一組あるいは複数組を、排気管の周りにスパイラル状に巻回し、巻始めの一端は透過気体を排気する排気管と透過気体流路材が連通するように排気管に気体分離膜を接着し、巻終わりの一端は透過気体流路を気密に閉じるように気体分離膜を袋状とし、巻終わりから巻始めに至る過程で、透過気体流路材を順次厚くした構成とすることにより、巻終わりから巻き始めに至る過程において透過気体の流量が順次増大しても、それに伴い流路材が順次厚くなり流路が大きくなるため、圧力損失による性能低下の無い、しかも体積効率の高い気体分離膜モジュールを実現できる。

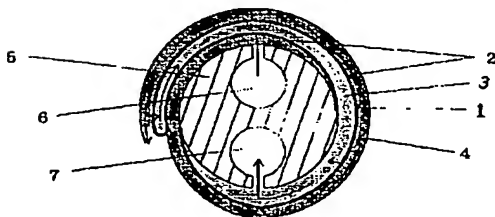
【図面の簡単な説明】

【図1】実施例1の気体分離膜モジュールの(a)断面*20

【図1】



【図4】



* 図および(b)展開断面図

【図2】実施例1の他の気体分離膜モジュールを展開した断面図

【図3】実施例1および2の気体分離膜モジュールの使用例を示す断面図

【図4】実施例2の気体分離膜モジュールの断面図

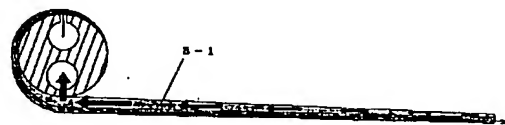
【図5】従来例1の気体分離膜モジュールの(a)断面図および(b)一部展開斜視図

【図6】従来例2の気体分離膜モジュールの(a)断面図、(b)一部展開斜視図および(c)展開断面図

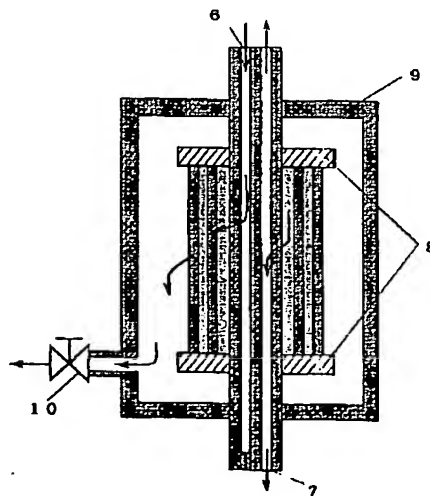
【符号の説明】

- 1 原料気体流路材
- 2 気体分離複合膜
- 3 透過気体流路材
- 4 気体非透過膜
- 5 給排気管
- 6 給気管
- 7 排気管
- 8 封止材

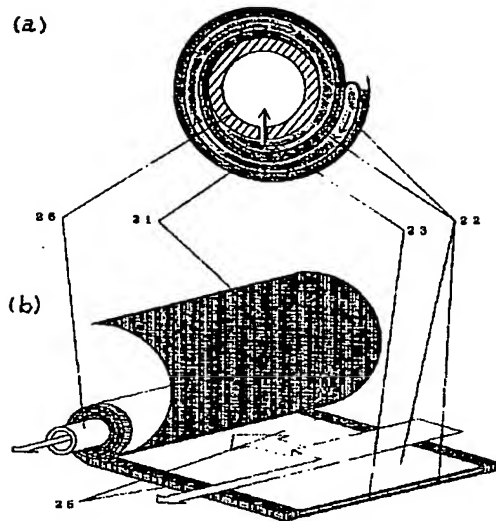
【図2】



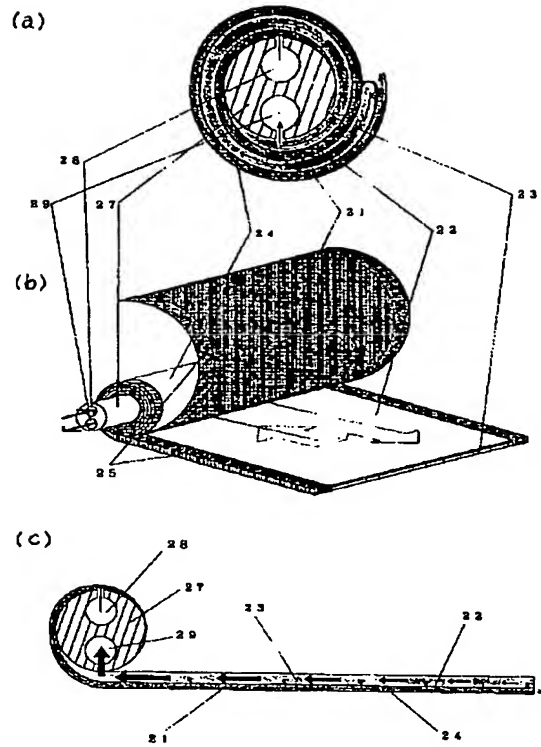
【図3】



【図5】



【図6】



【手続補正書】

【提出日】平成6年2月7日

【手続補正1】

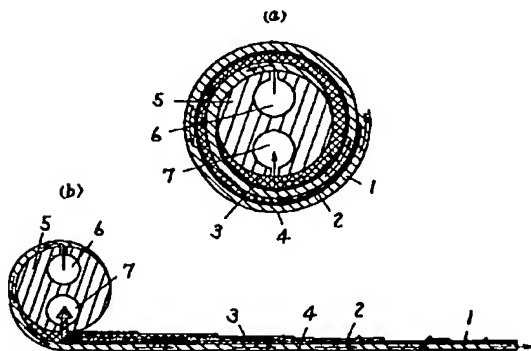
【補正対象書類名】図面

* 【補正対象項目名】全図

【補正方法】変更

* 【補正内容】

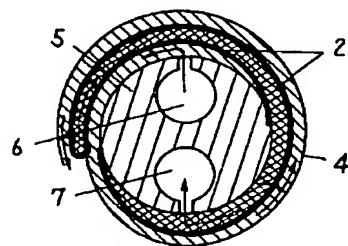
【図1】



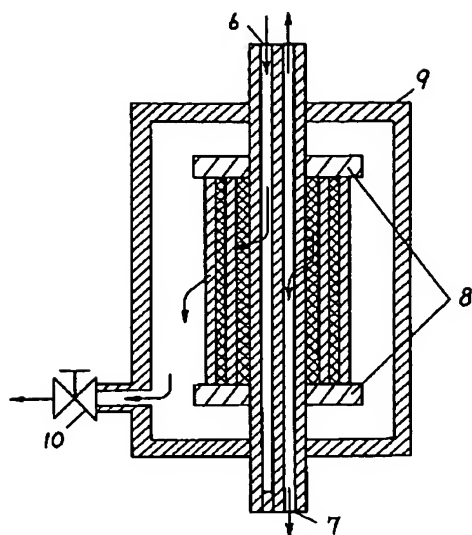
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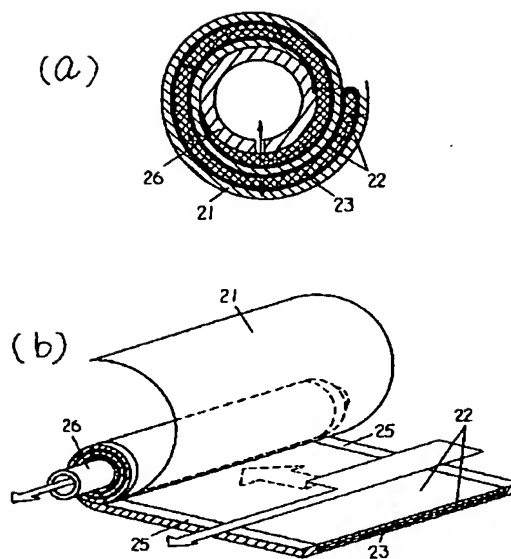
【図4】



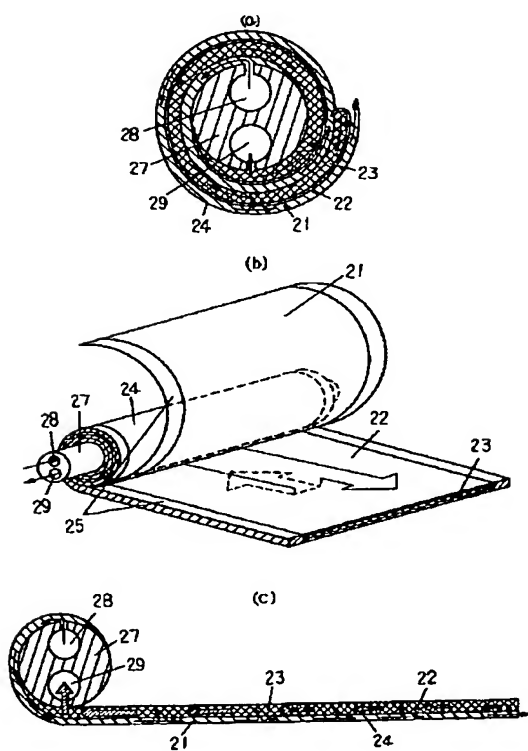
【図3】



【図5】



【図6】



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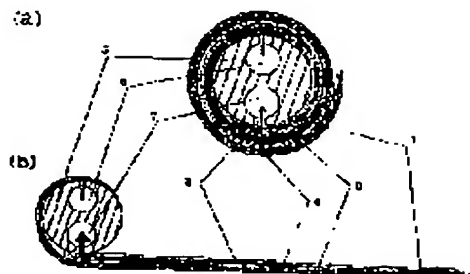
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(54) AIR SEPARATION MEMBRANE MODULE

(57)Abstract:

PURPOSE: To provide an air separation membrane module generating no lowering of capacity due to the pressure loss in a transmitted air passage and having high volumetric efficiency.

CONSTITUTION: A transmitted air passage material 3 is held between flat air separation membranes 2 partially constituted of an air impermeable membrane 4 and the air separation membranes 2 are spirally wound around an air supply and discharge pipe 5 having an air supply pipe 6 and an exhaust pipe 7 integrally provided thereto along with a raw material air passage material 1 and one winding start parts of the membranes 2 communicate with the raw material passage material 1 and the air supply pipe 6. The air separation membranes 2 are bonded to the air supply and discharge pipe 5 so that the transmitted air passage material and exhaust pipe 7 communicate each other and the winding end parts thereof form the air separation membranes 2 into a bag shape so as to airtightly close the transmitted air passage material 3 and both side end parts in the winding direction are sealed so as to airtightly separate a raw material air passage and a transmitted air passage and, in the process from winding end to winding start, the transmitted air passage material 3 is made successively thick.



LEGAL STATUS

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CLAIMS

[Claim(s)]

[Claim 1] Transparency gas passage material is inserted by flat film-like gas permeation membrane or the gas permeation membrane of the shape of a flat film by which the part was constituted from gas nontransparent film. The gas permeation membrane and the raw material gas passage material which sandwiched said transparency gas passage material are made into a lot in piles. Around air-supply-and-exhaust tubing with which the exhaust pipe which exhausts this feed pipe which supplies raw material air for a lot at least and transparency gas was united, in the shape of a spiral Winding, The feed pipe of raw material gas passage material and air-supply-and-exhaust tubing opens the first end of a volume for free passage. Said gas permeation membrane is pasted up on air-supply-and-exhaust tubing so that the exhaust pipe of transparency gas passage material and air-supply-and-exhaust tubing may be open for free passage. The end of a volume end makes said gas permeation membrane saccate so that transparency gas passage may be closed airtightly. The both-sides edge of the winding direction is the gas-permeation-membrane module which is a gas-permeation-membrane module closed so that raw material gas passage and transparency gas passage might be separated airtightly, is the process in which it results from a volume end at the beginning of a volume, and thickened said transparency gas passage material one by one.

[Claim 2] Transparency gas passage material is inserted by flat film-like gas permeation membrane or the gas permeation membrane of the shape of a flat film by which the part was constituted from gas nontransparent film. Close the both-sides edge of said gas permeation membrane, and the gas permeation membrane and the raw material gas passage material which sandwiched said transparency gas passage material are made into a lot in piles. At least, around an exhaust pipe, in the shape of a spiral, said gas permeation membrane is pasted up on an exhaust pipe so that this exhaust pipe with which the winding and first end of a volume exhausts a lot, and transparency gas passage material may open a transparency gas for free passage. The end of a volume end is the gas-permeation-membrane module which is a gas-permeation-membrane module which made said gas permeation membrane saccate as transparency gas passage is closed airtightly, is the process in which it results from a volume end at the beginning of a volume, and thickened said transparency gas passage material one by one.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the spiral mold gas-permeation-membrane module which comes to wind the gas separation bipolar membrane of a flat film.

[0002]

[Description of the Prior Art] The gas-permeation-membrane module of the spiral mold which generally comes to wind a flat film sandwiches the transparency gas passage material which forms transparency gas passage by flat film-like gas permeation membrane, it pastes up gas permeation membrane on hollow tubing so that transparency gas passage may be open for free passage in the hole of hollow tubing which has a hole, with the raw material gas passage material which forms raw material gas passage, is wound around the surroundings of hollow tubing and constituted. Moreover, in Japanese Patent Application No. No. 249711 [four to], the artificer etc. pasted up gas permeation membrane on hollow tubing so that transparency gas passage material and raw material gas passage material might be open for free passage in the hole of hollow tubing which has two or more independent holes, respectively, and he proposed the gas-permeation-membrane module constituted by winding around hollow tubing.

[0003] A raw material gas is made into air about separation of the gas of the above-mentioned conventional gas-permeation-membrane module, and concentration, and the case where separate nitrogen and it condenses is explained using drawing.

[0004] Drawing 5 and drawing 6 are the examples of the gas-permeation-membrane module of the conventional spiral mold. Drawing 5 (a), The cross-section perspective view in which (b) developed the sectional view of the gas-permeation-membrane module of the conventional example 1, and the gas-permeation-membrane module, respectively, Drawing 6 (a), (b), and (c) are the sectional view of the gas-permeation-membrane module of the conventional example 2, the cross-section perspective view which developed the gas-permeation-membrane module, and the sectional view which developed the gas-permeation-membrane module in which gaseous flow is shown, respectively.

[0005] In drawing 5 , 22 is the gas separation bipolar membrane of the shape of a flat film of having formed gas permeation membrane on the porosity base material, and by return, a clinch part rolls it and, finally it has become so that the transparency gas passage material 23 may be inserted. Moreover, the both-sides edge of the winding direction (it is perpendicularly to hollow tubing) of the gas separation bipolar membrane 22 is closed with the sealing agent 25, and the gas separation bipolar membrane 22 has pasted up the first end of a volume on the hollow tubing 26 so that the transparency gas passage material 23 and the hollow tubing 26 may be open for free passage. Raw material gas passage is released.

[0006] In the above-mentioned configuration, if raw material air is supplied to the raw material gas passage which consisted of raw material gas passage material 21 in the direction of an arrow head (continuous line), raw material air flows the front-face top of the gas separation bipolar

membrane 22 which penetrates oxygen preferentially. Then, oxygen flows and goes the transparency gas passage which penetrated the gas separation bipolar membrane 22 preferentially, and consisted of transparency gas passage material 23 in the direction of an arrow head (broken line), and is discharged from the hollow tubing 26. Therefore, it will pass through a gas separation bipolar membrane top, and, as for the air which came out from the gas-permeation-membrane module, nitrogen will be condensed.

[0007] Drawing 6 sandwiches the transparency gas passage material 23 by flat film-like the gas separation bipolar membrane 22 and the gas nontransparent film 24. Moreover, with the raw material gas passage material 21 By the gas-permeation-membrane module of the spiral mold wound around the surroundings of the air-supply-and-exhaust tubing 27 which has the independent feed pipe 28 and an exhaust pipe 29 The gas separation bipolar membrane 22 and the gas nontransparent film 24 are pasted up on the air-supply-and-exhaust tubing 27 so that a feed pipe 28, the raw material gas passage material 21, and an exhaust pipe 29 and the transparency gas passage material 23 may be open for free passage, respectively, and it has closed so that raw material gas passage and transparency gas passage may be further separated for the both-sides edge of the winding direction airtightly.

[0008] If raw material air is supplied from the feed pipe 28 of this spiral mold gas-permeation-membrane module, the front-face top of the gas separation bipolar membrane 22 is flowed in the direction of an arrow head (continuous line) in a raw material gas feeder current way, and nitrogen can be condensed by preferential transparency of oxygen like the gas-permeation-membrane module of the conventional example 1. By this gas-permeation-membrane module, when raw material air flows in the winding direction, distance in which raw material air flows a gas separation bipolar membrane front-face top can be lengthened, and a gas-permeation-membrane module with high concentration effectiveness is obtained.

[0009]

[Problem(s) to be Solved by the Invention] However, the thickness of the transparency gas passage material 23 of the above-mentioned conventional gas-permeation-membrane module becomes fixed [the cross section of the passage where a gas flows in the process in which it results at the beginning of a volume, from a volume end since it is fixed] anyway. On the other hand, as the flow rate of the transparency gas which flows the inside of the transparency gas passage material 23 is shown in drawing 6 (c), it is the process of gas separation bipolar membrane in which wind and it results [from the end] in a cut water, and sequential addition will be carried out, it will increase, and the transparency gas of the amount penetrated all over gas-permeation-membrane 22 will pass in an exhaust pipe 27 and a part open for free passage. It is proportional to increase of a flow rate, and flow resistance also increases, and when the thickness of transparency gas passage material is not enough, flow resistance becomes large, pressure loss is produced, predetermined differential pressure is no longer obtained through gas permeation membrane, and it becomes impossible that is, to secure sufficient engine performance in the transparency gas passage material of fixed thickness (the cross section of passage is fixed).

[0010] Moreover, it sets among transparency gas passage into the exhaust pipe with which a transparency gas flow rate increases most, and a part open for free passage. When the thickness of transparency gas passage material is determined that pressure loss will become small enough, Beyond the need, transparency gas passage material will become thick, the appearance of the wound gas-permeation-membrane module becomes large as it results [from an exhaust pipe] in a volume end part, since the thickness of transparency gas passage material is fixed, and the volumetric efficiency over the engine performance of a gas-permeation-membrane module will fall.

[0011] Since the method which carries out pressurization supply of the raw material gas is generally taken in the gas-permeation-membrane module of a spiral mold, the volume of a supply

gas drops to several [under atmospheric pressure / 1/]. since [on the other hand,] a transparency gas serves as atmospheric pressure — the flow rate of a transparency gas — several times of a supply gas — becoming — the thickness of transparency gas passage material — several times of raw material gas passage material — being needed . Therefore, the rate of a volume ratio which the transparency gas passage material in a gas-permeation-membrane module occupies becomes high, and it becomes the important technical problem of improvement in volumetric efficiency, i.e., the improvement in the engine performance, and a miniaturization how transparency gas passage material can be made thin.

[0012] This invention solves the above-mentioned conventional technical problem, and it aims at offering the gas-permeation-membrane module which was excellent in concentration effectiveness and volumetric efficiency.

[0013]

[Means for Solving the Problem] In order to attain this purpose the gas-permeation-membrane module of this invention Transparency gas passage material is inserted by flat film-like gas permeation membrane or the gas permeation membrane of the shape of a flat film by which the part was constituted from gas nontransparent film. The gas permeation membrane and the raw material gas passage material which sandwiched the above-mentioned transparency gas passage material are made into a lot in piles. Around air-supply-and-exhaust tubing with which the exhaust pipe which exhausts this feed pipe which supplies raw material air for a lot at least and transparency gas was united, in the shape of a spiral Winding, The above-mentioned gas permeation membrane is pasted up on air-supply-and-exhaust tubing so that the feed pipe of raw material gas passage material and air-supply-and-exhaust tubing may open the first end of a volume for free passage and the exhaust pipe of transparency gas passage material and air-supply-and-exhaust tubing may be open for free passage. The end of a volume end makes the above-mentioned gas permeation membrane saccate so that transparency gas passage may be closed airtightly. The both-sides edge of the winding direction is the gas-permeation-membrane module closed so that raw material gas passage and transparency gas passage might be separated airtightly, is the process in which it results from a volume end at the beginning of a volume, and has the configuration which thickened the above-mentioned transparency gas passage material one by one.

[0014] Moreover, transparency gas passage material is inserted by flat film-like gas permeation membrane or the gas permeation membrane of the shape of a flat film by which the part was constituted from gas nontransparent film. Close the both-sides edge of this gas permeation membrane, and the gas permeation membrane and the raw material gas passage material which sandwiched the above-mentioned transparency gas passage material are made into a lot in piles. At least, the above-mentioned gas permeation membrane is pasted up on an exhaust pipe so that, as for the winding and first end of a volume, this exhaust pipe that exhausts a transparency gas, and transparency gas passage material may open a lot for free passage in the shape of a spiral around an exhaust pipe. The end of a volume end is the gas-permeation-membrane module which made the above-mentioned gas permeation membrane saccate, as transparency gas passage is closed airtightly, it is the process in which it results from a volume end at the beginning of a volume, and has the configuration which thickened the above-mentioned transparency gas passage material one by one.

[0015]

[Function] The gas-permeation-membrane module with high volumetric efficiency which can reduce the high transparency gas passage material of the rate of a volume ratio in a gas-permeation-membrane module, and does not have the degradation by pressure loss since transparency gas passage material becomes thick one by one and passage becomes large in connection with it even if the flow rate of a transparency gas carries out sequential increase in the process in which it moreover results [from a volume end] in a cut water is realizable with

this configuration.

[0016]

[Example]

(Example 1) One example of this invention is explained below, referring to a drawing. The sectional view where, as for drawing 1 (a), the sectional view of the gas-permeation-membrane module of this example, drawing 1 (b), and drawing 2 developed the gas-permeation-membrane module, and drawing 3 are the examples of use of this example.

[0017] In drawing 1, 1 is raw material gas passage material, and has used one polyethylene shaping network with a thickness of 0.4mm of 15 meshes. 2 is gas separation bipolar membrane, it is the unsymmetrical structure which carried out the laminating of the gas permeation membrane of the Pori 4 methyl pentene 1 on the porosity base material, and carried out the laminating of the poly dimethylsiloxane on it further, and it is allotted so that a demarcation membrane side may face the raw material gas passage material 1.

[0018] 3 -- transparency gas passage material -- it is -- the polyethylene shaping network with a thickness of 0.4mm of 15 meshes -- 100cm from the end of a volume -- until -- it is one sheet, and after it, every 50cm, it increases one sheet at a time, a laminating is carried out, and it is constituted. 4 is polyester film with a thickness of 100 micrometers by the gas nontransparent film. As for 5, the feed pipe 6 and the exhaust pipe 7 are arranged independently in the die-length direction in parallel with air-supply-and-exhaust tubing, and the exterior and a hole open for free passage have opened in the feed pipe 6 and the exhaust pipe 7, respectively.

[0019] So that the above-mentioned raw material gas passage material 1 may be open for free passage to a feed pipe 6 and the transparency gas passage material 3 may be open for free passage to an exhaust pipe 7 The gas separation bipolar membrane 2 and the gas nontransparent film 4 are airtightly pasted up on the air-supply-and-exhaust tubing 5. After winding the ingredient of the gas nontransparent film 4 around the surroundings of the air-supply-and-exhaust tubing 5 in the shape of a spiral from the raw material gas passage material 1, The gas separation bipolar membrane 2 and the gas nontransparent film 4 are airtightly pasted up by the end in the volume end of the gas separation bipolar membrane 2, and like drawing 3, with a sealing agent 8, adhesion closure of other 2 sides is carried out so that raw material gas passage and transparency gas passage may be separated airtightly.

[0020] As compared with the gas-permeation-membrane module which the gas-permeation-membrane module constituted as mentioned above made only transparency gas passage material fixed thickness, and was created similarly, the amount of the transparency gas passage material used became half mostly, and the outer diameter of a gas-permeation-membrane module became small 30mm.

[0021] Moreover, nitrogen concentration was 97.5% when the nitrogen concentration air flow rate which contains the above-mentioned gas-permeation-membrane module in a pressurized container 9, supplies air $4.2 \times 10^{-4} \text{ m}^3/\text{s}$ (25 l/min) pressurized by 592Pa (5 kgf/cm²G) from the feed pipe 6, and is obtained from a flow control valve 10 was adjusted at $8.3 \times 10^{-5} \text{ m}^3/\text{s}$ (5 l/min), as shown in drawing 3.

[0022] According to this example, transparency gas passage material is inserted by the gas nontransparent film and flat film-like gas permeation membrane as mentioned above. The gas permeation membrane and the raw material gas passage material which sandwiched transparency gas passage material are made into a lot in piles. Around air-supply-and-exhaust tubing with which the feed pipe which supplies raw material air for a lot or two or more of these sets, and the exhaust pipe which exhausts a transparency gas were united, in the shape of a spiral Winding, The feed pipe of raw material gas passage material and air-supply-and-exhaust tubing opens the first end of a volume for free passage. The gas nontransparent film and gas permeation membrane are pasted up on air-supply-and-exhaust tubing so that the exhaust pipe of transparency gas passage material and air-supply-and-exhaust tubing may be open for free

passage. It is the process in which the end of a volume end pastes up nontransparent gas transparency material and gas permeation membrane on saccate so that transparency gas passage may be closed airtightly, close the both-sides edge of the winding direction so that raw material gas passage and transparency gas passage may be separated airtightly, and it results from a volume end at the beginning of a volume. By thickening transparency gas passage material one by one, a gas-permeation-membrane module with high volumetric efficiency is obtained.

[0023] In addition, comparatively, since [of the space per unit volume of a network] the optimal value is determined by the recovery (ratio of the nitrogen concentration air content over an air-supply air content) of the permeability ability of gas permeation membrane, the gas separation engine performance, and a gas-permeation-membrane module etc., the number of laminatings of the network which constitutes the transparency gas passage material 3 of the gas-permeation-membrane module of this example, and the die length of each network which is carrying out the laminating are not limited to the value of this example.

[0024] Moreover, although the laminating of the transparency gas passage material 3 of the gas-permeation-membrane module of this example was carried out and the polyethylene rennet was used for it, this is not limited especially if the nonwoven fabric using the foaming form using the network which used resin, such as polypropylene and a polyvinyl chloride, or urethane, polystyrene, etc., or polyester etc. is the shaping resin article which forms gaseous passage.

[0025] Furthermore, although considered as the configuration which carried out the laminating of the network of fixed thickness in this example, as shown in 3-1 of drawing 2, it can be good also as a configuration which fabricated a network and the above-mentioned passage material in one so that thickness might change smoothly, volumetric efficiency can become good in this case, deformation of the gas permeation membrane by the level difference of a network can also be avoided, and a rolling-up man day can also be reduced.

[0026] (Example 2) The 2nd example of this invention is explained below, referring to drawing 4.

[0027] Although 1 is the configuration same at raw material gas passage material as an example 1, winding lay length has dropped to 1/2. Although 2 is the same configuration as an example 1 in gas separation bipolar membrane, turn up so that the transparency gas passage material 3 may be inserted, and it is made for a clinch part to serve as a volume end, and it has closed the both-sides edge. Moreover, the gas nontransparent film 4 has pasted the clinch part of the gas separation bipolar membrane 2, and the gas nontransparent film 4 has covered the periphery of the gas separation bipolar membrane 2. From the end of a volume to 50cm is one sheet, and 3 is taken as the configuration which increased one sheet at a time and carried out the laminating every 25cm after it, although this is also the same configuration as an example 1 in transparency gas passage material.

[0028] The gas separation bipolar membrane 2 is airtightly pasted up on the air-supply-and-exhaust tubing 5, and the ingredient of the gas nontransparent film 4 is wound around the surroundings of the air-supply-and-exhaust tubing 5 in the shape of a spiral from the raw material gas passage material 1 so that the above-mentioned raw material gas passage material 1 may be open for free passage to a feed pipe 6 and the transparency gas passage material 3 may be open for free passage to an exhaust pipe 7. The outer diameter of this gas-permeation-membrane module became small 10mm compared with the gas-permeation-membrane module of an example 1.

[0029] Nitrogen concentration was 97.4% when the nitrogen concentration air flow rate which contains the gas-permeation-membrane module constituted as mentioned above in a pressurized container 9 as shown in drawing 3, supplies air $4.2 \times 10^{-4} \text{ m}^3/\text{s}$ (25 l/min) pressurized by 592Pa (5 kgf/cm²G) from the feed pipe 6, and is obtained from a flow control valve 10 was adjusted at $8.3 \times 10^{-5} \text{ m}^3/\text{s}$ (5 l/min).

[0030] According to this example, transparency gas passage material is inserted as mentioned

above by the gas permeation membrane of the shape of a flat film by which the part was constituted from gas nontransparent film. The gas permeation membrane and the raw material gas passage material which sandwiched this transparency gas passage material are made into a lot in piles. Around air-supply-and-exhaust tubing with which the feed pipe which supplies raw material air for a lot or two or more of these sets, and the exhaust pipe which exhausts a transparency gas were united, in the shape of a spiral Winding, The feed pipe of raw material gas passage material and air-supply-and-exhaust tubing opens the first end of a volume for free passage. Gas permeation membrane is pasted up on air-supply-and-exhaust tubing so that the exhaust pipe of transparency gas passage material and air-supply-and-exhaust tubing may be open for free passage. It is the process in which make it the end of the volume end of gas permeation membrane serve as a clinch part of gas permeation membrane, close the both-sides edge of the winding direction so that raw material gas passage and transparency gas passage may be separated airtightly, and it results from a volume end at the beginning of a volume. By thickening transparency gas passage material one by one, transparency gas passage material can be reduced further and volumetric efficiency can be improved more.

[0031]

[Effect of the Invention] According to this invention, transparency gas passage material as mentioned above Flat film-like gas permeation membrane, Or it inserts by the gas permeation membrane of the shape of a flat film by which the part was constituted from gas nontransparent film. The gas permeation membrane and the raw material gas passage material which sandwiched this transparency gas passage material are made into a lot in piles. Around air-supply-and-exhaust tubing with which the feed pipe which supplies raw material air for a lot or two or more of these sets, and the exhaust pipe which exhausts a transparency gas were united, in the shape of a spiral Winding, The feed pipe of raw material gas passage material and air-supply-and-exhaust tubing opens the first end of a volume for free passage. Gas permeation membrane is pasted up on air-supply-and-exhaust tubing so that the exhaust pipe of transparency gas passage material and air-supply-and-exhaust tubing may be open for free passage. It is the process in which the end of a volume end makes gas permeation membrane saccate so that transparency gas passage may be closed airtightly, close the both-sides edge of the winding direction so that raw material gas passage and transparency gas passage may be separated airtightly, and it results from a volume end at the beginning of a volume. The configuration which thickened said transparency gas passage material one by one, or flat film-like gas permeation membrane, Or transparency gas passage material is inserted by the gas permeation membrane of the shape of a flat film by which the part was constituted from gas nontransparent film. Close the both-sides edge of gas permeation membrane, and the gas permeation membrane and the raw material gas passage material which sandwiched transparency gas passage material are made into a lot in piles. A lot or two or more of these sets in the shape of a spiral around an exhaust pipe Winding, It is the process in which the first end of a volume pastes up gas permeation membrane on an exhaust pipe so that the exhaust pipe and transparency gas passage material which exhaust a transparency gas may be open for free passage, the end of a volume end makes gas permeation membrane saccate so that transparency gas passage may be closed airtightly, and it results from a volume end at the beginning of a volume. Since passage material becomes thick one by one and passage becomes large in connection with it, even if the flow rate of a transparency gas carries out sequential increase in the process in which it results [from a volume end] in a cut water by considering as the configuration which thickened transparency gas passage material one by one, A gas-permeation-membrane module with volumetric efficiency high moreover without the degradation by pressure loss is realizable.

[Translation done.]

* NOTICES *

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- 1.This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.*** shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The (a) sectional view and (b) expansion sectional view of a gas-permeation-membrane module of an example 1

[Drawing 2] The sectional view which developed other gas-permeation-membrane modules of an example 1

[Drawing 3] The sectional view showing the example of use of the gas-permeation-membrane module of examples 1 and 2

[Drawing 4] The sectional view of the gas-permeation-membrane module of an example 2

[Drawing 5] the (a) sectional view of the gas-permeation-membrane module of the conventional example 1, and (b) -- a part -- an expansion perspective view

[Drawing 6] the (a) sectional view of the gas-permeation-membrane module of the conventional example 2, and (b) -- a part -- an expansion perspective view and (c) expansion sectional view

[Description of Notations]

- 1 Raw Material Gas Passage Material
- 2 Gas Separation Bipolar Membrane
- 3 Transparency Gas Passage Material
- 4 Gas Nontransparent Film
- 5 Air-Supply-and-Exhaust Tubing
- 6 Feed Pipe
- 7 Exhaust Pipe
- 8 Sealing Agent

[Translation done.]